**IN THE UNITED STATES PATENT AND TRADEMARK OFFICE**

| | |
|---|---|
| Applicant: Soumyadeb Ghosh, et al. | Group Art Unit: 1714 |
| Serial No.: 10/675,108 | Examiner: Kriellion Antionette Sanders |
| Filing Date: September 30, 2003 | |
| For: ELECTRICALLY CONDUCTIVE COMPOSITIONS, METHODS OF MANUFACTURE THEREOF AND ARTICLES DERIVED FROM SUCH COMPOSITIONS | |

Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

DECLARATION PERSUANT TO 37 C.F.R § 1.131

Sir:

The inventors of the above referenced patent declare and say:

1. We, Soumyadeb Ghosh and Sumanda Bandyopadhyay declare and say that we are inventors in the above-referenced application (the '108 application).

2. We have read and are familiar with the Office Action dated December 20, 2006 as well as with U.S. Patent Application No. 2002/0183438 to Amerasekera et al. (Amerasekera) filed on November 15, 2001, which claims priority to Provisional Application No. 60/287,127 April 27, 2001. The publication date for Amerasekera was December 5, 2002.

3. We conceived the invention disclosed and claimed in the above-identified patent application prior to December 5, 2002.

4. As evidence in support of this prior invention, submitted herewith is the following evidence. Exhibit A is a copy of the record of invention submitted to the Docketing Department at the General Electric Company.

4. The undersigned declares that all statements made herein of his own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of this application or any patent issuing thereon.

Date: 8/5/07

S. Ghosh.

Soumyadeb Ghosh

Date: 8/5/2007

Sumanda Bandyopadhyay

Sumanda Bandyopadhyay

Appendix A

Dumoulin, Blanche M (Research)

From: Legal Docket Room (Research)
Sent: [redacted]
To: Legal Docket Room (Research)
Subject: Invention Submission

REQUIRED FIELDS FOR OPENING DOCKETS
2.5 - EMAIL OF THE DISCLOSURE
DOCKET Number: RD30674

[redacted]

ABSTRACT: A high aspect ratio conducting particle, graphite, has been used in conjunction with a conducting particle with low percolation threshold, such as conducting carbon black, in compositions of conducting thermoplastic composites. Such combination of fillers impart higher conductivity to the material per weight/volume fraction of the filler loading, maintaining processibility and mechanical properties of the material.

TITLE: ELECTRICALLY CONDUCTIVE COMPOSITIONS CONTAINING CARBON PARTICLES OF DIFFERENT SHAPE, SIZE AND FORMS

Inventor(s)
Lead Co-inventor
Soumyadeb nmn Ghosh
Home Address:2661, 18th Main, 4th Cross, HAL 2nd stage Bangalore
India 560008
India
Citizenship: Indian
Profession: GE Employee
SS#: 00240
Global Technology Center: Polymer & Specialty Chemical Technologies (2100)
Lab: India
GE Corporate Research & Development

Sumanda nmn Bandyopadhyay
Home Address:425 1st cross, 9th main, Indiranagar Bangalore
India 560 038
Citizenship: Indian
Profession: GE Employee
SS#: 102860414
Global Technology Center: Polymer & Specialty Chemical Technologies (2100)
Lab: India
GE Corporate Research & Development

GE Technology Areas:
Corporate R&D Advanced Technology Programs
Corporate R&D CEO Programs
GE Appliances (APPL)
GE Medical Systems (MSXX)
GE Plastics (PLAS)
GE Power Systems (PGXX)
Six Sigma and DFSS

[redacted]

PROJECT NAME: conducting composites
PROJECT NUMBER: PSM/CEP/CCS/2002/022

Visitors
Name: Ramesh nmn Krishnamurti

Address: 3327 7th Cross, 13th Main, HAL II stage, Indranagar Bangalore

Email: ramesh.krishnamurti@geind.ge.com

Citizenship: Indian

Visitors
Name: somnath nmn ganguly

Address: 95,AECS LAYOUT,I CROSS,RMV II STAGE BANGALORE

Email: somnath.gangulys@geind.ge.com

Citizenship: INDIAN

Visitors
Name: Sanjay Gurabasappa Charati

Address: 522 D Block, Natasha Golfview Apts. Domlur Bangalore

Email: sanjay.charati@geind.ge.com

Citizenship: Indian

Visitors
Name: Hema nmn Sridhar

Address: No,9, Clark's Pete Bangalore

Email: hema.sridhar@geind.ge.com

Citizenship: Indian
ASSIGNED ATTORNEY: Noreen Johnson

View disclosure letter at http://weblcrdge.crd.ge.com/functional_orgs/giplo/eDisclosure/

## GE Patent Disclosure Letter System

DOCKET NUMBER

30674

DOCKET DATE

[redacted]

TITLE OF INVENTION

ELECTRICALLY CONDUCTIVE COMPOSITIONS CONTAINING CARBON PARTICLES OF DIFFERENT SHAPE, SIZE AND FORMS

GE TECHNOLOGY AREA(S)

- Corporate R&D Advanced Technology Programs
- Corporate R&D CEO Programs
- GE Appliances (APPL)
- GE Medical Systems (MSXX)
- GE Plastics (PLAS)
- GE Power Systems (PGXX)

**Keywords:**

- Six Sigma and DFSS

PROJECT NAME

conducting composites

PROJECT NUMBER

PSM/CEP/CCS/2002/022

PROJECT LEADER

Charati, Sanjay

BUSINESS OR ORG. CONTACT INFORMATION

**NAME** Ann Burnell

**PHONE NUMBER** 233-5288

**Was this invention first conceived or reduced to practice in the performance of work under a contract between GE and another non-government third party?** NO

**Date Invention Conceived :** [redacted]

**Circumstances Invention Conceived i.e., described in patent notebook (include page #), technical report, letter, discussed in meeting minutes, etc.**
patent notebook

**Was this invention first conceived or reduced to practice in the performance of work under a US Government contract?**
NO

ABSTRACT OF THE INVENTION

**Please write a brief explanation of the invention (Limit to 350 words)**
A high aspect ratio conducting particle, graphite, has been used in conjunction with a conducting particle with low percolation threshold, such as conducting carbon black, in compositions of conducting thermoplastic composites. Such combination of fillers impart higher conductivity to the material per weight/volume fraction of the filler loading, maintaining processibility and mechanical properties of the material.

BACKGROUND OF THE INVENTION

**Please describe the problem or requirement addressed by your invention.**

The invention relates broadly to composites that contain electrically conductive particles. Conductivity in such systems is achieved by the flow of electrons between particles that are in contact or in close proximity of each other. Hence, the conductivity follows the percolation behavior in such systems - the material becomes conducting only when the loading of the conducting fillers is above a critical level. The conductivity increases steeply with filler loading above the critical level, reaching almost a saturation value. In an ideal case the saturation conductivity is very close to that of the pure filler. However in most cases, due to the contact resistance at the particle-to-particle contacts, the conductivity saturates at a much lower value, depending on the filler, the matrix and the

other components, if any. The main cause of contact resistance is wetting of the filler particles by the matrix polymer. Hence, full advantage of the filler conductivity is not obtained.

**How has this problem or requirement been addressed before?**

To overcome the filer-to-filler contact resistance, the polymer matrices with low wettability can be chosen. Further, the composite is loaded to a very high level with filler so that the amount of the polymer is not enough to fully wet the total particle surface. This leads to direct particle-particle contact and hence to high conductivity. High filler loading however, causes deterioration of the mechanical properties and processiblity of the composites. Melt processing techniques such as injection molding, required to mass produce objects with intricate shape, can not be used for formulations with high filler loadings. More time-costing methods such as compression molding, are used for such systems. For the mechanical intrigrity of the material at high filler loadings, a thermoset resins are often used, which form crosslinked continuous phase holding the particles.

**Is this disclosure letter related to any GE disclosure letters, patent applications or issued patents?**

NO

**Have you completed a prior art search?** YES

**Please list any relevant literature or patents of which you are aware.**

DETAILED DESCRIPTION OF THE INVENTION

**How does your invention work?**

In the present invention, combination two types conducting fillers of widely different shape, are compounded with various thermoplastics such as polycarbonate, nylon and polyphenylene sulfide, for production of injection moldable composite materials. One of conducting filler can be high aspect ratio graphite, metal flakes or metal coated high aspect ratio particles, where as the other conducting filler can be conducting carbon black, carbon fiber, metal powders or metal coated powders. In a typical example, graphite is used as the major component (50%-90% by weight of the composite)in the system. The other conducting filler, conducting carbon black, is used only in small amount (0.5 - 15% by weight of the composite) depending on the graphite content, type of carbon, the nature of the polymer matrix etc. Such combination of fillers substantially increases the

conductivity of the composites for a particular level of total filler loading. Three times increase in conductivity was observed when 2% graphite is replaced with conducting carbon black at 70% total filler loading in a polycarbonate composite.

**Describe the important features of your invention and explain how to use the invention to solve the problems described above.**

In the present invention, a conducting filler having low percolation threshold (e.g. carbon black)in two component polymeric systems, is used to electrically bridge the insulating matrix between the high aspect ratio particles (e.g. grapphite), used as the major component. Further, use of spherical particles disrupts the packing of the high aspect ratio flat particles in the composites. This increases the exposed surface area of the filler phase, which for a polymer-deficient formulation can not be fully wetted by the matrix phase, increasing the direct filler-filler conact area and hence the conductivity. Hence, addition of even small amount of carbon increases the conductivity by a few factors for a particular total filler loading in a graphite-carbon-thermoplastic composition. The main distinctive feature for the invention compared to the earlier work, is its emphasis on increasing the quality of the inter-particulate contacts in the regime of high level of filler loading, rather than focusing on increasing the number of contacts, and hence decreasing the percolation threshold, by controlling various parameters including those used in the present work.

**What advantages are provided by your invention?**

Possiblity of achieving a required conductivity at a lower filler loading enhances the ease of processing, the mechanical properties and decreases the sloughing of the filler from the material surface, apart from cutting the cost due to the filler.

**Has your invention been reduced to practice?** NO

**Briefly describe any efforts to make a prototype of your invention or to test your invention. Additionally, summarize the results of any related experiments and testing and highlight any results of particular significance.**

The matrix polymer in powder form was first dry mixed with fillers in required amounts and melt-compounded in a Buss kneader. The pelletized composite materials were then injection molded into bars and the conductivity measured using four probe method. For 70% total filler content in polycarbonate, 3 times increase in conductivity was observed for a composition containing 2% conducting carbon black and

68% graphite, compared to the composition containg only graphite as the conducting filler. The detailed result is given as an attachment.

BRIEF DESCRIPTION OF THE DRAWINGS

**Please describe the significance of any pictures, drawings, graphs, diagrams, structures or figures and the type of picture along with the specific view or application to the invention.**

Conductivities of graphite (Crystal Vein graphite – Asbury,USA) composites with or without conducting carbon black as additives, in polycarbonate (PC-175). The legend for the bars from left to right are for compositions:- i) without any carbon ii) with 1 wt.% conducting carbon black iii) with 2 wt.% conducting carbon black iv) with 4% untreated carbon nanotubes v) with 4% heat-treated carbon nanotube.

CLAIMED INVENTION

**Please identify novel aspects that should be protected within this disclosure letter.**

1)Use of two or more types of conducting fillers with very different shapes for optimum packing density of the filler in the composite. 2) Use a filler as the major component in the composition that has minimal effect on the mechanical properties, in conjunction with another filler with low percolation threshold to electrically bridge between the particles of the major conducting component. 3) The major component can be graphite, metal flakes, metal coated high aspect ratio particles. The the other conducting filler can be conducting carbon black, carbon fiber, metal particles, metal coated particles.

ATTACHED FILES

CVG_C_PDL-atch01.ppt
ptnt_crbn-grpht_PDL-attach01.doc

| DUTY OF DISCLOSURE | | |
|---|---|---|
| a. | **Have steps been taken to put into use, either outside GE or in our own operations?** | No |
| b. | **Has the invention or a product embodying or using it been sold or offered for sale?** | No |
| c. | **If the invention pertains to a process, have any steps been taken to employ the process commercially (e.g., for product production)?** | No |
| d. | **Has the invention been described in an electronic or printed publication?** | No |
| | | |

| | | |
|---|---|---|
| e. | Has the invention been described to persons who are not employees of GE? | No |
| f. | Are there results available of a prior art search pertaining to this invention? | Yes |
| g. | Has anyone else associated with the project within GE (marketing, sales, sourcing, etc.) disclosed the invention or offered the invention for sale? | No |
| h. | If you answered Questions a-g as "NO", is any use, sale, publication, or disclosure of the invention now contemplated? | No |

CO-INVENTORS

| Name | Address | Glob |
|---|---|---|
| Sumanda Bandyopadhyay | 102 Benaka Towers, 2nd cross, 16th D main, HAL 2nd Stage<br>Bangalore, India<br>zip - 560 008 | Polyr |
| *Soumyadeb Ghosh | 2661, 18th Main, 4th Cross, HAL 2nd stage<br>Bangalore, India<br>zip - 560008 | Polyr |

**Lead co-inventor*

**Associated Lab/Program:** Polymer & Specialty Chemical Technologies (2100)/India

**Assigned Attorney:** Noreen Johnson